

Advanced Manufacturing Technologies (AMT): Additive Construction for Mobile Emplacement Project

Game Changing Development Program | Space Technology Mission Directorate (STMD)



ABSTRACT

As the nation prepares to return to the Moon, or journey on to Mars or to an asteroid, it is apparent that the viability of long duration visits with appropriate radiation shielding/crew protection hinges on the development of planetary surface structures, preferably in advance of a crewed landing, and preferably utilizing in-situ resources. The Additive Construction with Mobile Emplacement (ACME) project will focus on the development of technologies to support automated development of in-situ materials-based, planetary surface structures, including roads, berms, radiation, blast and micro-meteoroid protection, and pressurized and un-pressurized structures. The Marshall Space Flight Center (MSFC) will team with Kennedy Space Center (KSC), Contour Crafting, Inc. (CCI), and the US Army Corps of Engineers (USACE) to execute this effort.

ANTICIPATED BENEFITS

To NASA unfunded & planned missions:

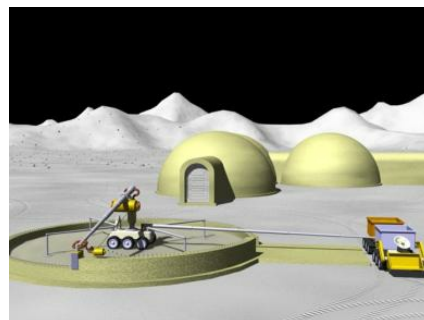
This project will benefit NASA as it develops concepts for habitat development on other planets, where launch upmass is at a premium and in-situ materials lend themselves well as construction materials.

To other government agencies:

This project benefits the US Army Corps of Engineers (USACE) in their attempts to develop automated construction systems to replace plywood-based B-huts currently in use. These resulting structures would take less time to build, require less mass brought in-theater, require fewer personnel, have less waste, and could be left for local populations to inhabit when finished.

DETAILED DESCRIPTION

Conventional methods of manufacturing automation do not lend themselves to construction of large structures with internal

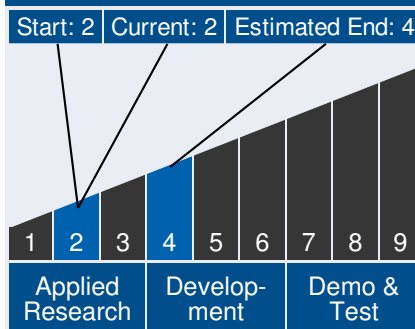


Conceptual Design of a Lunar Additive Construction Habitat

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Technology Maturity



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features, especially if various other components (such as reinforcement, pipes, sensors, etc) are to be installed within the structure. This explains why the evolution of construction automation has been slow. While well known in parts manufacturing, a promising new automation approach in construction is layered fabrication, generally known as solid free form fabrication or additive manufacturing. However, most of the current layered fabrication methods are limited by their ability to deliver a wide variety of materials applicable to construction (especially if those materials are local, or in-situ). Additionally, they are severely constrained by the low rates of material deposition which makes them attractive only for the fabrication of small industrial parts. The ACME project will utilize additive construction expertise previously developed at MSFC and CCI, automation and robotics expertise from KSC, and fundamental construction knowledge developed by the USACE to develop and expand the knowledge base associated with automated construction of planetary surface structures using in-situ materials. Areas of emphasis will include characterization of typical Lunar and Martian regolith materials (using terrestrially-developed simulant materials), optimization of binder materials for each regolith, development of sub-scale followed by full-scale regolith beneficiation and processing, handling and transport and actual mobilitydeposition hardware, and development of automated cleaning processes.

Management Team

Program Executive:

- Ryan Stephan

Program Manager:

- Stephen Gaddis

Project Manager:

- John Vickers

Principal Investigator:

- Lanetra Tate

Technology Areas

Primary Technology Area:

Human Exploration Destination Systems (TA 7)

- └ Sustainability and Supportability (TA 7.2)
 - └ Repair Systems (TA 7.2.3)
 - └ Additive Manufacturing (Three-Dimensional (3D) Printing) (TA 7.2.3.9)

Secondary Technology Area:

Human Health, Life Support, and Habitation Systems (TA 6)

Additional Technology Areas:

Human Exploration Destination Systems (TA 7)

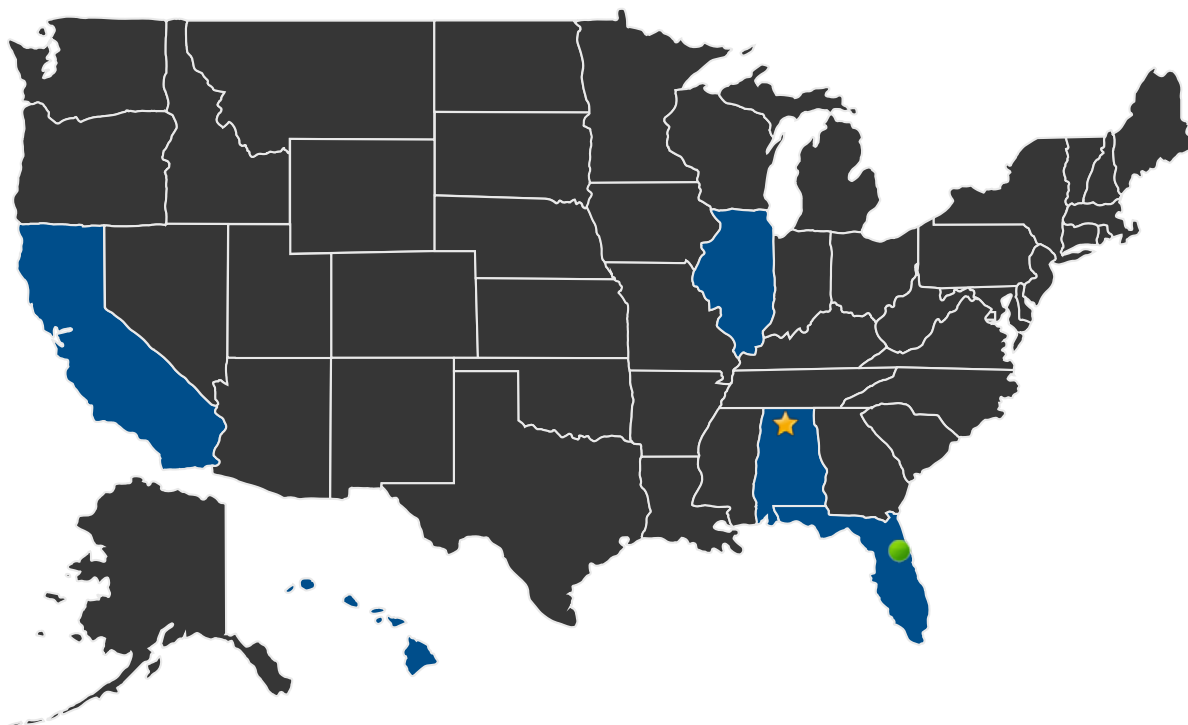
- └ Sustainability and Supportability (TA 7.2)

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U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States With Work

★ **Lead Center:**
Marshall Space Flight Center

● **Supporting Centers:**

- Kennedy Space Center

Other Organizations Performing Work:

- US Army Corps of Engineers

Contributing Partners:

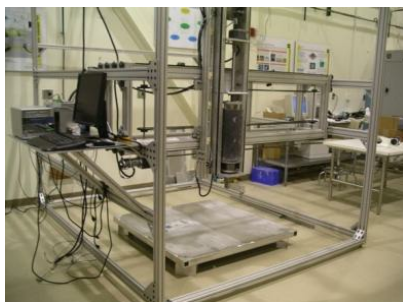
- Contour Crafting, Inc. (CCI)
- Pisces, Inc.

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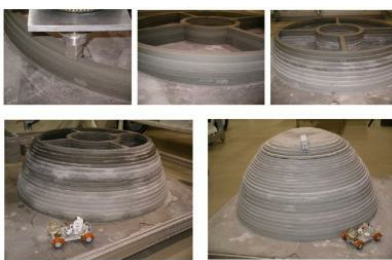
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IMAGE GALLERY



MSFC Additive Construction Research & Development Laboratory



Additive Construction of Concrete Dome in MSFC Additive Construction Research Laboratory

DETAILS FOR TECHNOLOGY 1

Technology Title

Additive Construction Using In-Situ Materials

Technology Description

This technology is categorized as a hardware system for ground scientific research or analysis

The ACME project employs layered fabrication techniques on a much larger scale, using in-situ materials, to generate surface structures to support a manned presence on non-Earth planetary bodies.

Capabilities Provided

The ACME project will allow, for the first time, the development of surface structures on non-Earth planetary bodies, using local materials, thereby tremendously reducing launch upmass.

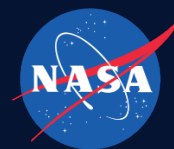
Potential Applications

Potential terrestrial applications include the development of surface structures using Earth-based materials for emergency response, disaster relief, housing at all economic levels, and other applications as desired.

Active Project (2014 - 2017)

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Performance Metrics

Metric	Unit	Quantity
Deposition Rate	in/min	30